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The Impact of Digital Transformation on Enterprise Innovation: Based on The Empirical Analysis of Listed Companies

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Abstract: Based on the 2011-2020 Digital Finance Index and the data of Shanghai and Shenzhen A-share listed companies, the panel fixed utility model is used to investigate how the digital transformation of companies affects the innovation ability of enterprises. The research finds that the digital transformation of enterprises can have a significant positive effect on the improvement of the innovation and innovation ability of enterprises. The digital transformation of enterprises can promote the improvement of the innovation ability of enterprises by affecting the financing constraints, and then enable the innovation of enterprises； further research finds that enterprise digital transformation has a more significant positive effect on the innovation ability of private enterprises.

Keywords: Digital Economy; Financing constraint; Enterprise innovation.

1. Introduction

As the most active field in China's economic development, the digital economy has continuously expanded the breadth and depth of integration with various fields of economy and society, and plays an important role in stimulating consumption, stimulating investment and creating employment. From a domestic perspective, the relevant data of the China Academy of Information and Communications shows that the scale of China's digital economy was 22.4 trillion yuan in 2016 and 35.8 trillion yuan in 2019, accounting for 36.2% of GDP, and a nominal growth of 15.6% compared with the same period last year, much higher than the GDP growth rate. From an international perspective, the 2019 Digital Economy Report released by the United Nations Conference on Trade and Development points out that the United States and China are becoming the main leaders in this field, accounting for 90 percent of the market capitalization of the world's 70 largest digital platforms, with China's Tencent and Alibaba among seven of these "super platforms." China's digital economy has gradually become an important component and growth driver of the national economy under the rapid growth of scale.China is emerging as the dominant leader in this space, accounting for 90 percent of the market capitalization of the world's 70 largest digital platforms, with China's Tencent and Alibaba among seven of these "super platforms." China's digital economy has gradually become an important component and growth driver of the national economy under the rapid growth of scale.

Since the "13th Five-Year Plan" period, China's digital economy has entered the fast track of development, and digital transformation has gradually become a new driving force for national economic growth. In this context, the deep integration of digital technologies such as the Internet, big data and artificial intelligence with the real economy will empower the transformation and upgrading of traditional industries and improve enterprise productivity [1][2] .In the face of ever-changing markets and increasingly fierce competition, can Chinese enterprises explore the development path combining digital transformation and enterprise innovation and promote high-quality economic development? It has become a hot topic in academic circles.

By combing through previous studies, we can find that digital transformation has a positive effect on enterprise innovation. Some scholars believe that the development of the Internet can directly and indirectly promote the efficiency and level of regional innovation[3]. At the same time, digital economy mainly affects enterprise innovation performance through technology diversification channels [4]. Digital transformation can effectively improve the performance of enterprises, help enterprises reduce costs and increase efficiency, and enhance the impetus for innovation. However, existing studies generally focus on the role of digital transformation at the macro level, and few start from the perspective of micro digital transformation of enterprises and focus on enterprise innovation itself. In the long run, innovation will bring more competitive advantages, more super profits and higher market value to enterprises[5]. However, due to the high failure rate, large capital demand and long cycle of innovation projects[6], financing constraints are large and the willingness of enterprises to innovate is often not strong. This paper believes that the digital transformation path based on the integration of artificial intelligence, blockchain, cloud computing, big data and other technologies with the real economy is likely to become the thrust of enterprise innovation.

The follow-up arrangement of this paper is as follows: The second part reviews and summarizes the existing literature; The third part analyzes the relationship between digital transformation and enterprise innovation and puts forward the hypothesis of this paper. The fourth part introduces the data source, describes the related variables, and establishes the econometric analysis model. The fifth part shows the benchmark regression results and analyzes the transmission mechanism of digital transformation on enterprise innovation. The sixth part puts forward the conclusion and enlightenment of this study.

2. Theoretical Analysis and Research Hypotheses

Digital transformation is not the simple combination and application of digital technologies, but the elevation of data to a new production factor and innovation output driver as important as people, capital and land. From the perspective of China's current situation, the country regards digital transformation as an important strategic deployment, and has issued documents for many times to vigorously cultivate new digital formats and seek the organic combination of digital economy and real economy. Combing through the previous literature, the role of digital transformation in the real economy mainly has the following three points: First, the digital transformation of enterprises can help enterprises reduce costs and increase efficiency, and improve production and operation efficiency. In the face of massive and non-standard data, digital technology can be used as an effective means of data processing to help enterprises use information efficiently and cheaply, achieve internal production and external market demand matching, and then optimize the production process. Second, the digital transformation of enterprises can significantly reduce the degree of information asymmetry. The reason is that companies can not only process internal information through digital transformation, but also communicate information to market participants, enabling information to be open, connected and shared. Third, enterprise digital transformation can effectively enhance enterprise value and financing capacity. As an important part of the national macro development blueprint, digital transformation is consistent with the current development trend of the digital economy. Based on this, policy-oriented digital enterprises will be more recognized by the capital market, with higher valuations and stronger financing capabilities.

Digital transformation has gradually become endogenous and integrated into the daily operation and decision-making process of enterprises. From an internal perspective, it is clear that the initiative, ability and results of digital transformation will also affect the degree of digital transformation. Before the implementation of digital transformation, the information of enterprises in production, logistics, sales and other aspects can not form a system, and therefore can not provide decision-making advice for enterprises. digital transformation integrates scattered information and resources of enterprises, optimizes the connection between supply and demand, and fully improves the future operation efficiency of enterprises[7], so that enterprises can achieve higher marginal innovation output. At the same time, the combination of digital transformation and real economy can give full play to its "multiplier" creation effect[8], activate idle resources, achieve the deep integration of cross-border resources, and empower enterprises to innovate. Based on this, the discussion of enterprise digital transformation and what channels will affect enterprise innovation has important theoretical significance for in-depth understanding of enterprises' motivation and benefits of digital transformation

Specifically, enterprise innovation will be subject to financing constraints[9], management incentives[10], innovation failure tolerance[11],innovation attention and other factors. With the characteristics of high failure rate, low certainty, large capital demand and long cycle of innovation projects, enterprises now begin to rely on the enabling effect of digital transformation on enterprise innovation. The disclosure of the concept and orientation of digital transformation by enterprises has the following effects on enterprise innovation: it can release positive signals of their own transformation and upgrading to external information users such as financial institutions and government agencies, effectively alleviate the information asymmetry and financing constraints between enterprises and market participants, and empower enterprises to innovate; To sum up, digital transformation mainly enhances enterprises' innovation willingness and promotes enterprise innovation through financing constraints.

Based on this, this paper proposes hypothesis 1: Digital transformation can help improve the level of enterprise innovation.

Financing constraint is an important factor affecting the innovation activities of enterprises. Innovation investments are different from material investments, which makes them more vulnerable to financial constraints. Due to its large scale of investment, high uncertainty and long payback period, it is often difficult to obtain stable and sufficient internal funds from the enterprise itself. In terms of external financing, because enterprises are reluctant to provide accurate information about their innovation projects to financial institutions, it is difficult to guarantee the quality of the projects, and innovation investment cannot be pledged by tangible assets, resulting in information asymmetry and adverse selection, resulting in credit rationing or the increase of financing costs. Especially for developing countries, the constraints on innovation investment are more significant due to the imperfect financial market.

From the perspective of financing constraint theory, when the project with positive net present value needs investment but the internal financing is insufficient, the enterprise will obtain external funds to promote the project. When enterprises have limited access to internal and external funds, enterprises lacking available funds will be more inclined to invest in short-term profitable projects, and reduce the willingness to invest in high-risk, high-investment, long-term innovation projects with uncertain returns[12,13]. Therefore, one way to promote innovation is to ease the financing constraints that companies face.

When evaluating the innovation activities of enterprises, the traditional financial industry often reduces or refuses to lend due to the limitations and uncertainties of information (uncertain income, uncertain cycle, etc.), resulting in insufficient supply of gold for innovative enterprises. But in the context of digital transformation, first, digital finance, due to the combination of finance and digital technology, can cover all regions to the greatest extent and benefit all enterprises. The digital transformation of enterprises sends positive signals. As the main body of information production, the digital transformation information disclosed by enterprises not only means that enterprises will have greater investment in this aspect, but also indicates the high-quality development of enterprises in the future. Second, based on the financial technology supported by the digital economy, it can effectively broaden the service boundaries of financial enterprises. External fund providers can better identify and reduce risks in the credit process through enterprise disclosure, improve the efficiency and effect of credit resource allocation.[14] Digital finance overcomes the shortcomings of financial institutions such as banks, and its network advantages and digital technology reduce the problems existing in the old financial system such as banks, speed up

the approval speed and simplify the approval procedure. The communication cost between banks and enterprises is reduced, the consumption of relevant resources is relatively low, and it is easier to stimulate the innovation vitality of enterprises. Second, the traditional financial system, dominated by banks, requires a large amount of data to record procedures, and there is the possibility of errors in manual processing. While solving such problems, digital finance allows enterprises to participate in the process through the Internet platform, improving the efficiency of enterprises in using financial redundant resources, and thus realizing the "throttling" in the process of development of enterprises. Third, there is often a high information asymmetry between the traditional financial system represented by banks and enterprises. State-owned enterprises can better obtain the support of traditional financial institutions by relying on the government background, while private enterprises have big problems in obtaining the support of the traditional financial system. At the same time, it is difficult for institutions under the traditional financial system to have sufficient impetus to provide more support for the digital innovation of private enterprises. However, digital finance draws the spatial and temporal distance between financial institutions and enterprises, improves the communication efficiency of financial institutions when assessing corporate borrowing risks, reduces information asymmetry, and at the same time, resources can also play a role in the areas where their utility can be maximized. Companies will also become more willing to go green. Fourth, digital finance enables individual investors to understand corporate information in more detail, enabling them to participate more actively in the capital market. In recent years, as the state attaches great importance to environmental protection, individual investors will have higher expectations for the future development prospects of innovative enterprises, and are more inclined to invest in such enterprises, thus easing the financing constraints faced by enterprises, increasing the financial redundancy of enterprises, and promoting enterprises to innovate. Therefore, the application and development of digital technology greatly reduces the degree of information asymmetry between external capital providers and enterprises, optimizes the capital structure of enterprises, and reduces the capital cost of enterprises. Therefore, digital transformation can ease the financing constraints of enterprises and empower enterprises to innovate

Based on this, this paper proposes hypothesis 2: financing constraints play an intermediary effect between digital transformation and enterprise innovation level.

Due to differences in factors such as the nature of equity ownership, state-owned enterprises can better obtain the support of traditional financial institutions by relying on the government background, while private enterprises have big problems in obtaining the support of traditional financial system. Meanwhile, it is difficult for institutions under the traditional financial system to have sufficient impetus to provide more support for the digital innovation of private enterprises. Therefore, the degree of digital transformation has different effects on the innovation performance of enterprises. Due to the existence of these objective differences, the impact of digital transformation degree on enterprise innovation should not be simply regarded as incentive effect, so it is necessary to explore the impact of digital transformation degree on innovation output under different property rights background. Based on this, hypothesis 3 is proposed.

Hypothesis 3: The degree of digital transformation has heterogeneity on the enterprise innovation performance of state-owned enterprises and private enterprises.

3. Research Design

3.1. Sample source

This paper takes Chinese listed companies from 2011 to 2020 as research samples. The number of patent applications of enterprises came from the CNRDS database, and the data on the degree of digital transformation of enterprises, the identification data of high-tech enterprises and other financial variables were all from the CSMAR database. Finally, a total of 25702 observations were obtained in this paper. All kinds of data in this paper were collected from the CSMAR database, and in order to eliminate the influence of outliers, the first and last 1% tail processing was carried out on the data. The following data reports were based on the data results after processing, and the empirical analysis was carried out with stata16 software.

3.2. Primary variable

Primary variable: For the first time, Wu Fei [15]et al. used the word frequency of "digital transformation" related words in the annual report of listed companies as a measure of the degree of digital transformation of enterprises. They believe that previous studies mainly use virtual variables of whether an enterprise has carried out digital transformation as proxy variables, which can not well measure the degree of enterprise digital transformation. As a summary and oriented external report, the annual report of an enterprise is the carrier of information transmission to external information users. The willingness and results of an enterprise to actively carry out digital transformation are likely to be reflected in the annual report of an enterprise. Therefore, it is reasonable to use the word frequency of "enterprise digital transformation" in the annual report to measure the degree of digital transformation. Specifically, the CSMAR database cited in this paper covers terms in five categories when calculating the degree of enterprise digital transformation: artificial intelligence, blockchain, cloud computing, big data, and digital technology applications, which is consistent with previous research.The names of specific subdivisions are shown in Table 1.

Based on this, this paper sums up the word frequencies of five categories to measure the degree of enterprise digital transformation (dig). Since the data has the feature of "right-bias", this paper carries out logarithmic processing on this basis, and the specific calculation formula is as follows:

$$Lndig_{i,t} = Ln(\text{AI+BC+CC+BD+DTA+1}) \quad (1)$$

3.3. Enterprise innovation

Patent application reflects the results of innovation projects invested by enterprises, and can measure the innovation ability of enterprises. At the same time, the number of patent applications is closer to the actual time of innovation output than the number of patents granted, which can more truly reflect the level of innovation. Therefore, this paper refers to the practice of Li Chuntao et al[16]., Li Wenjing and Zheng Manni[17], and takes the number of patent applications as the proxy variable of enterprise innovation. Patent data also has the characteristics of "right bias", this paper takes the natural logarithm of the number of patent applications after adding 1.

In order to alleviate the possible reverse causation problem, the patent application is also dealt with in the future phase. The specific calculation formula is as follows:

Table 1. Digital transformation segmentation indicators

Index class	Segmentation index name
Artificial Intelligence Technology (AI)	Artificial intelligence, Business intelligence, image understanding, investment decision aid systems, intelligent data analysis, intelligent robotics, machine learning, deep learning, semantic search, biometrics, face recognition, speech recognition, authentication, autonomous driving, natural language processing
Blockchain Technology (BC)	Digital currency, smart contracts, distributed computing, decentralization, Bitcoin, alliance chain, differential privacy technology, consensus mechanism
Cloud Computing Technology (CC)	Memory computing, cloud computing, stream computing, graph computing, Internet of Things, multi-party secure computing, brain-like computing, green computing, cognitive computing, Fusion architecture, 100 million level concurrency, EB level storage, information physical systems
Big Data Technology (BD)	Big data, data mining, text mining, data visualization, heterogeneous data, credit information, augmented reality, mixed reality, virtual reality
Digital Technology Applications (DTA)	Mobile Internet, Industrial Internet, mobile Internet, Internet medical, e-commerce, mobile payment, third-party payment, NFC Payment, B2B, B2C, C2B, C2C, O2O, Internet connection, smart wear, smart agriculture, smart transportation, smart medical, smart customer service, smart home, smart investment, smart travel, smart environmental protection, smart grid, smart energy, smart marketing, digital marketing, unmanned retail, Internet finance, digital finance, Fintech, financial technology, Quantitative finance, open banking

$$inn_{i,t+1} = Ln(\text{PatentApplei， t+1+1}) \quad (2)$$

3.4. Other variables

This article refers to the existing literature, In the model, the company Size (Size) is expressed as the natural logarithm of the business income of the enterprise, the asset-liability ratio (Lev) is the total liabilities of the enterprise divided by the total assets, the proportion of fixed assets (PPE), the fixed assets of the enterprise divided by the total assets, the return on total assets (ROA) is equal to the net profit divided by the total assets, and the net cash from operating activities divided by the total assets (CR). SOE is 1 if it is a state-owned enterprise, or 0 if it is not, and TobinQ is equal to the total shareholders' equity divided by the company's market value as the control variable. In addition, the year fixed effect and individual fixed effect are added.

3.5. Research model

To test hypothesis 1, the following model is set up:

$$inn_{it+1} = \beta_0 + \beta_1{}'Dig_{it} + \beta_i Cotrols_{\text{it}} + \mu_t + \lambda_i + \varepsilon_{it} \quad (3)$$

Where, inn_{it+1} represents the innovation capability of the enterprise, Dig_{it} represents the degree of digital transformation of the enterprise, $Cotrols_{it}$ including the control variables mentioned above, μ_t represents the fixed effect of the year, λ_i represents the fixed effect of the enterprise. The main coefficient concerned in this paper is $\beta_1{}'$ .If hypothesis 1 is true, that is, enterprise digital transformation has a significant promoting effect on enterprise innovation, then $\beta_1{}'$ should be significantly positive.

In order to ensure the robustness of the results, the following treatments are carried out in this paper: First, considering that the transmission of digital transformation to enterprise innovation takes some time, and there may be reverse causality problem, the natural logarithm of the number of patent applications in the future period plus 1 is selected as the explained variable; Second, in order to avoid the influence of extreme values, all continuous variables were tail-tailed at 1% and 99% quantiles. Third, year and individual fixed effects were added to all regression models at the same time, and standard errors were clustered at the enterprise level to minimize errors caused by model factors.

To test hypothesis 2, with reference to Wen Zhonglin and Ye Baojuan's practice[18], a causal stepwise regression model was constructed to test the intermediary effect:

$$KZ_{it} = \gamma_0 + \gamma_1{}'\text{Dig}_{\text{it}} + \gamma Cotrols_{\text{it}} + \mu_{\text{t}} + \lambda_{\text{i}} + \varepsilon_{\text{it}} \quad (4)$$

$$inn_{it} = \alpha_0 + \alpha_1{}'\text{Dig}_{\text{it}} + \alpha_2 KZ_{it} + \alpha Cotrols_{\text{it}} + \mu_{\text{t}} + \lambda_{\text{i}} + \varepsilon_{\text{it}} \quad (5)$$

4. Empirical Results and Analysis

4.1. Descriptive statistics

Table 2 shows the descriptive statistics of the main variables. The results show that the difference of enterprise innovation (Inn) is obvious. The degree of enterprise digital Transformation (dig) showed similar characteristics, with a minimum of 0 and a median of 2.7 DIGs and an average of 2.77 digs, meaning that more than half of the sample had undertaken digital transformation.

4.2. Reference regression

Table 3 shows the results without adding control variables and fixed effects, without adding control variables but adding fixed effects, and adding control variables and fixed effects at the same time. The regression coefficient of dig is significant at the level of 1% and above, indicating that digital transformation has a significant promoting effect on enterprise innovation. Hypothesis 1 is valid. From the point of view of the fitting degree of the model, with the introduction of control variables and fixed effects, the adjusted R2 of the model increased from 0.085 to 0.580, indicating that the introduction of control variables and fixed effects strengthened the model's interpretation of the explained variables. From an economic point of view, an

increase of one standard deviation (1.211) in the degree of digital transformation of an enterprise will increase its innovation capacity by about 0.219(0.173×1.273).

Table 2. Descriptive Statistics of Variables

variable	N	mean	p50	sd	min	max
inn	25702	2.538	2.708	1.796	0	9.607
dig	25702	2.776	2.708	1.273	0	6.909
size	25702	21.31	21.20	1.512	17.52	25.44
Lev	25702	0.432	0.425	0.208	0.0547	0.908
PPE	25702	0.208	0.174	0.161	0.00164	0.698
ROA	25702	0.0354	0.0379	0.0755	-0.371	0.211
CR	25702	0.169	0.129	0.136	0.00732	0.660
Soe	25702	0.347	0	0.476	0	1
TobinQ	25702	0.307	0.283	0.164	0.0103	0.782
KZ	25702	0.754	0	2.078	-11.34	13.66

Table 3. Regression Results

	(1)	(2)	(3)
	inn	inn	inn
dig	0.410***	0.349***	0.173***
	(0.008)	(0.009)	(0.008)
size			0.547***
			(0.007)
lev			-0.591***
			(0.065)
PPE			-0.155**
			(0.066)
ROA			0.165
			(0.129)
CR			-0.404***
			(0.073)
Soe			0.131***
			(0.020)
TobinQ			-0.265***
			(0.065)
_cons	1.404***	0.498***	-10.493***
	(0.024)	(0.142)	(0.194)
year	no	Yes	Yes
industry	no	Yes	Yes
province	no	Yes	Yes
N	25702.000	25702.000	25702.000
r2	0.085	0.443	0.587
ar2	0.085	0.434	0.580

Standard errors in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

4.3. Robustness test

1. Considering that digital transformation and enterprise innovation may have the endogenous problem of mutual causation, this paper will explain the variable lag one stage to investigate the causal relationship between enterprise digital transformation and enterprise innovation ability. The specific test results are shown in the first column of Table 3. The results of one-stage lag are generally consistent with the aforementioned main results in terms of coefficient symbol and significance level, which partly verifies the robustness of the results in this paper.

2. Replacement of explained variables In order to eliminate the influence of the selection of explained variable indicators on the regression results, this paper increases the number of invention patents by 1 and takes the natural logarithm for another test. The test results are shown in column 2 of Table 3. It can be seen that after changing the explained variables, the digital transformation of enterprises is significantly positive at the 1% level, which verifies the robustness of the results in this paper.

Table 4. Robustness Results

	(1) inn	(2) linn
ldig	0.058***	
	(0.003)	
size	3.564***	12.172***
	(0.064)	(0.170)
lev	-0.191***	-0.575***
	(0.025)	(0.066)
PPE	-0.071***	-0.150**
	(0.025)	(0.066)
ROA	0.121**	0.153
	(0.048)	(0.130)
CR	-0.181***	-0.382***
	(0.028)	(0.074)
Soe	0.027***	0.138***
	(0.007)	(0.020)
TobinQ	-0.009	-0.290***
	(0.025)	(0.065)
dig		0.175***
		(0.008)
_cons	-10.376***	-36.611***
	(0.196)	(0.523)
year	Yes	Yes
industry	Yes	Yes
province	Yes	Yes
N	23899.000	25702.000
r2	0.554	0.584
r2_a	0.545	0.576

Standard errors in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

4.4. The impact mechanism of digital transformation on enterprise innovation: easing financing constraints

Because technological innovation needs a lot of technology and talents, enterprises have an increasing demand for capital in the process of technological innovation. [17]Li Wenjing and Zhu Xi 'an found that financing constraints seriously hindered the improvement of enterprises' technological innovation ability by studying enterprises in strategic emerging industries with relatively greater capital demand. However, facing serious financing constraints, enterprises will improve the efficiency of capital utilization and resource allocation, so they will choose the path of technological innovation more carefully to reduce the risk of technological innovation.

Due to the unsound capital market system and imperfect market environment, the main reason why enterprises face financing constraints is information asymmetry. Based on the signal transmission theory, the increase of R&D intensity and technological innovation results can convey the signal of good operation of enterprises to the media, shareholders and potential investors, attract resources and value investors for enterprises, and effectively alleviate the financing constraints of enterprises and solve the capital problem.

Therefore, with reference to the practice of Wen Zhonglin and Ye Baojuan[18], this paper adopts the three-step regression method to investigate the relationship among financing constraints, digital transformation and enterprise innovation ability. At the same time, some literatures also use KZ index to measure the financing constraints faced by enterprises, so this paper uses KZ index to test the intermediary path and mechanism between enterprises' digital transformation and enterprises' innovation ability. The larger the kz index is, the greater the financing constraint of enterprises. The specific test results are shown in Table 5.

As can be seen from Table 5, the degree of digital transformation, financing constraints and innovation ability are significantly correlated at 1% level, and the degree of broken digital transformation and financing constraints are significantly negatively correlated at 5% level. Combined with the main regression, it can be seen that financing constraints play a partial intermediary effect between the degree of digital transformation and the innovation ability of enterprises.

4.5. Heterogeneity analysis of enterprise digital transformation degree

Enterprises with different ownership types in China have differences in digital transformation, which will have a non-negligible heterogeneous incentive effect on the innovation performance of enterprises with different ownership. In Table 6, Columns 1 and 2 show the impact of enterprises' digital transformation on the innovation ability of state-owned enterprises and private enterprises respectively. It can be seen that enterprise digital transformation has a significant incentive effect on the innovation performance of both private and public enterprises, and the positive impact of enterprise digital transformation on the innovation ability of private enterprises is relatively greater, indicating that the impact of enterprise digital transformation on enterprises is heterogeneous. Therefore, hypothesis 3 is confirmed.

Table 5. Descriptive Statistics of Variables

	(1) KZ	(2) inn
dig	-0.023**	0.159***
	(0.011)	(0.010)
size	-0.330***	0.552***
	(0.010)	(0.010)
lev	3.656***	-0.419***
	(0.086)	(0.084)
PPE	-0.956***	-0.149*
	(0.084)	(0.079)
ROA	-9.925***	0.163
	(0.184)	(0.186)
CR	-8.180***	-0.433***
	(0.093)	(0.105)
Soe	0.325***	0.120***
	(0.026)	(0.024)
TobinQ	-3.381***	-0.292***
	(0.087)	(0.084)
KZ		-0.015**
		(0.007)
_cons	11.050***	-10.641***
	(0.248)	(0.244)
year	Yes	Yes
industry	Yes	Yes
province	Yes	Yes
N	17763.000	17752.000
r2	0.749	0.577
r2_a	0.742	0.566

Standard errors in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

Table 6. Heterogeneity Results

	(1) inn	(2) inn
dig	0.170***	0.160***
	(0.010)	(0.015)
size	0.501***	0.601***
	(0.010)	(0.012)
lev	-0.441***	-0.744***
	(0.078)	(0.120)
PPE	0.100	-0.259**
	(0.089)	(0.106)
ROA	0.278*	-0.053
	(0.143)	(0.280)
CR	-0.333***	-0.913***
	(0.085)	(0.142)
Soe	0.000	0.000
	(.)	(.)
TobinQ	-0.243***	-0.125
	(0.076)	(0.125)
_cons	-9.339***	-11.789***
	(0.254)	(0.316)
year	Yes	Yes
industry	Yes	Yes
province	Yes	Yes
N	16181.000	9521.000
r2	0.548	0.688
r2_a	0.536	0.677

Standard errors in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

5. Conclusion

Based on the 2011-2020 Digital Finance Index and the data of Shanghai and Shenzhen A-share listed companies, this paper uses A panel fixed utility model to examine how a company's digital transformation affects its innovation ability. The research results show that enterprise digital transformation can have a significant positive effect on the improvement of enterprise innovation and innovation ability. Enterprise digital transformation can promote the improvement of enterprise innovation ability by influencing financing constraints, and then enable enterprise innovation.

Digital transformation is closely related to enterprise innovation, and the improvement of enterprise digital transformation can enhance the R&D and innovation ability of enterprises. Second, since technological innovation is closely related to financing constraints, reducing the financing constraints of enterprises can promote the improvement of enterprises' innovation ability, and at the same time has positive significance for high-quality economic development. Third, digital transformation can solve the financing difficulties faced by enterprises to a certain extent, thus promoting enterprise innovation. Therefore, from the perspective of enterprises, they should not only actively carry out digital transformation, give full play to their supervision and management functions within the organization, and improve the incentive for enterprise innovation activities, but also improve the information transparency of innovation projects, reduce the information asymmetry with banks, governments and other capital providers, and effectively promote enterprise innovation and improve enterprise value from the perspective of easing financing constraints.

As a "big data strategy" vigorously developed by the country, the national and local governments continue to strengthen their efforts to promote digital development. Therefore, based on this, it is taken as the main research object of this paper, which has positive inspiration and reference value for policy makers to improve and optimize policies supporting enterprise innovation. On the one hand, we should improve the laws and regulations on internal control and accounting quality, strengthen information supervision, and improve the quality and level of information disclosure. On the other hand, we should further improve the financial market through digital technology, break information barriers, create a fair and open financing environment for enterprises, and promote the implementation of China's digital transformation policy.

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